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Pediatric Transesophageal Echocardiography

Present and Future

In this issue of ANESTHESIOLOGY, Muhiudeen *et al.* have compared the accuracy of intraoperative epicardial and transesophageal echocardiography (TEE) to pre- and postoperative precordial echocardiography, for anatomic diagnosis and postsurgical findings.[1] As a direct comparison of these two imaging techniques when applied by the same investigators to the same group of patients, this is a useful summary of the strengths and weaknesses of each imaging modality. Many of the present findings have previously been reported by the same authors.[2]

Both intraoperative imaging techniques confirmed the majority of preoperative diagnoses, including different forms of atrial and ventricular septal defects, tetralogy of Fallot, transposition of the great arteries, persistent truncus arteriosus, and various types of anatomic valvar and subvalvar obstruction to both ventricular outflow tracts. Both intraoperative techniques prospectively identified persistent left superior vena cava to coronary sinus connections as well as multiple muscular defects of the interventricular septum that had been incorrectly diagnosed preoperatively. Particular problems for TEE, which in their study used the transverse plane almost exclusively, included the identification and localization of doubly committed subarterial ("supracristal") ventricular septal defects, visualization of the right ventricular outflow tract (thereby precluding an adequate assessment following repair of tetralogy of Fallot), and precise quantification of residual outflow tract stenosis (because of the present unavailability of continuous-wave Doppler echocardiography on commercially available TEE probes). Epicardial echocardiography could not adequately visualize sinus venosus defects of the atrial septum with associated anomalies of pulmonary venous drainage but was especially useful for imaging the right ventricular outflow tract and quantifying residual stenoses.

By comparison with postoperative precordial echocardiography, both imaging techniques tended to overestimate valvular regurgitation immediately following surgery and, in a number of cases, failed to detect residual perimembranous ventricular septal defects. Neither of these findings is particularly surprising. Rapid changes in cardiac preload, afterload, atrioventricular conduction, and in some cases, cardiac function, immediately after cessation of cardiopulmonary bypass each may influence the extent of valvular regurgitation, thereby accounting for the lack of concordance between the severity of immediate postoperative valvular regurgitation assessed by TEE and by subsequent precordial echocardiography.[3] Residual perimembranous and doubly committed subarterial ventricular septal defects are often directed anteriorly into the body or the outflow tract of the right ventricle and would therefore not be optimally imaged in the transverse plane by TEE.

The importance of biplane TEE (with probes small enough to be used in pediatric patients) has been alluded to by Muhiudeen *et al.*[1] Transverse plane TEE permits adequate visualization of most of the atrial septum (following closure of defects or interatrial baffle procedures) and is undoubtedly optimal for viewing the mitral and tricuspid valves together with the posterior ventricular septum, for example after repair of atrioventricular septal defects.[4] However, we and other observers[5–7] have found that longitudinal plane imaging is preferable for the intraoperative assessment of many other cardiac malfor-

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Address reprint requests to Dr. Sahn: Division of Pediatric Cardiology, University of California, San Diego Medical Center 8445, 225 Dickinson Street, San Diego, California 92103.

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mations, including the sinus venosus portion of the atrial septum, and also is preferable after reconstruction of the left and right ventricular outflow tracts (for example, resection of subaortic stenosis or as part of tetralogy repair), cavopulmonary shunts and Fontan procedures, creation of extracardiac conduits, anatomic correction (arterial switch) for transposition of the great arteries, and the Rastelli procedure (for persistent truncus arteriosus and complex transpositions). Many residual ventricular septal defects, for reasons mentioned above, also are best imaged in the longitudinal plane.

As with conventional precordial echocardiography, the majority of congenital cardiac malformations need to be visualized in more than one plane in order to be fully appreciated (and in some cases, seen at all). Biplane pediatric TEE probes, allowing simultaneous or sequential visualization of the transverse and longitudinal planes and measuring less than 7 mm in diameter, have already been developed and tested even in newborns weighing 2 kg or less.[8] Once such biplane probes become more widely available, intraoperative TEE will come to be regarded as an important and indispensable aid for many of the operations in this report as well as for the most complex surgical procedures. Technological advances in TEE probes, including continuous-wave Doppler capability[9] and omniplane probes capable of imaging in any desired axis,[10] combined with the increased amount of time required for the complete assessment of many complex repairs and the interruption to surgery required for epicardial imaging, will then surely bring an end to routine intraoperative epicardial echocardiography.

R. G. WEINTRAUB, M.B., B.S.
Postdoctoral Research Scholar

D. J. SAHN, M.D.
Professor in Pediatrics and Radiology
Department of Pediatrics
Division of Pediatric Cardiology
University of California, San Diego Medical Center
San Diego, California

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